REVIEW ARTICLE

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Management of Class II open bite in a growing patient using the Invisalign Teen system: A case report

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KEY WORDS *Class II malocclusion, clear aligners, growing patient, Invisalign Teen system, invisible orthodontics, open bite*

When associated with anterior open bite, Class II malocclusions have proven to be a daunting challenge for orthodontists. Aligner systems now seem to be able to treat various types of malocclusions, and in recent years, many studies have demonstrated their efficacy in correcting crowding, misalignment and diastemas, and even complex cases involving open bite and poor occlusal relationships. The present case report describes the management of Class II malocclusion and open bite in a growing patient using the Invisalign Teen system (Align Technology, San Jose, CA, USA). A specific protocol was followed during treatment planning: transverse expansion, control of the vertical dimension, and sagittal correction using Class II elastics. Clear aligners proved to be highly effective in the resolution of Class II malocclusion and open bite, inducing molar intrusion and repositioning of the mandible.

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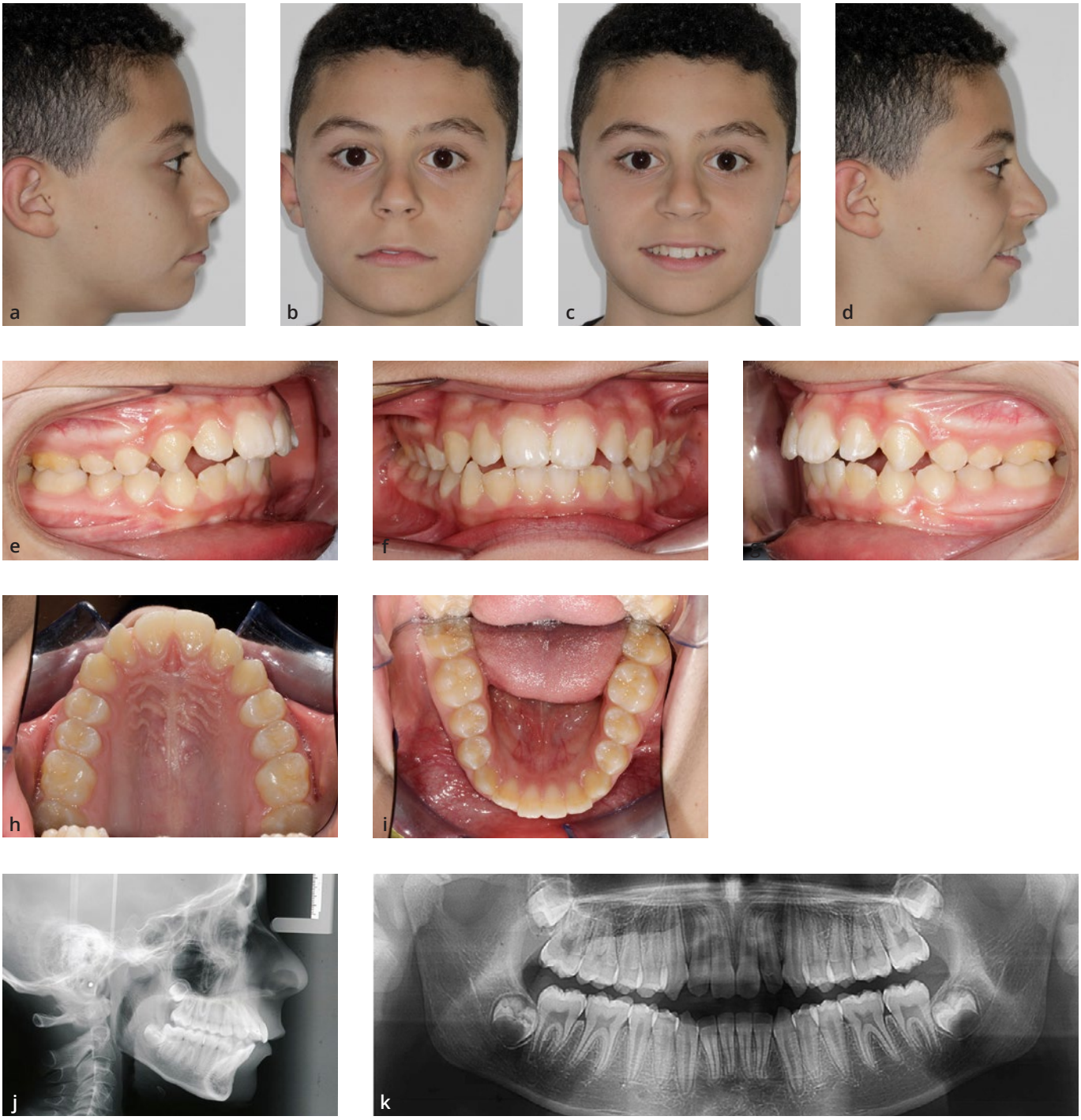
Introduction

Class II malocclusion can be due to skeletal or dental maxillary protrusion, mandibular retrusion, or a combination of factors[1-3]. When associated with anterior open bite, Class II malocclusions have proven to be a daunting challenge for orthodontists. Several aetiological factors are involved in this type of malocclusion, such as facial growth pattern, sucking habits, tongue thrusting, mouth breathing and postural mandibular imbalance. Other factors like severity and time of initial treatment can make management of Class II malocclusion with open bite correction and stability more difficult to achieve[4].

Recent systematic reviews and meta-analyses have shown that treatment of Class II malocclusion produces greater skeletal mandibular effects when performed during puberty (CS3 according to the cervical vertebral method [CVM])[5-7]. An effective and universally accepted treatment strategy for this type of malocclusion in growing patients involves promoting mesial repositioning of the mandible to correct the Class II dentoskeletal relationship[8]; maxillary expansion is performed initially to facilitate functional mandibular advancement and posterior intrusion to rotate the mandible upwards and forwards with control of oral habits, which helps to resolve open bite.

Aligner systems now seem to be able to treat various types of malocclusions, and in recent years, many studies have shown their high level of efficacy in correcting crowd-



Figs 1a-k Pretreatment records for an 11-year-old boy with a skeletal Class II relatio nship and open bite.

ing, misalignment and diastemas, and even complex cases involving open bite and poor occlusal relationships[9-13].

The use of elastics to correct Class II malocclusion can be reasonably effective with clear aligner treatment in growing patients that are fully compliant in wearing the elastics as directed by the orthodontist. The present case report discusses the management of Class II malocclusion and open bite in a growing patient using the Invisalign Teen system (Align Technology, San Jose, CA, USA).

Table 1 Cephalometric data

Variable		Norm	Pretreatment	Posttreatment
Sagittal skeletal	SNA, degrees	82.0 ± 2.0	80.0	80.0
	SNB, degrees	80.0 ± 2.0	73.0	77.0
	ANB, degrees	2.0 ± 2.0	7.0	3.0
	WITS, mm	0.0 ± 2.0	2.0	−2.0
Vertical skeletal	FMA, degrees	25.0 ± 3.0	26.0	25.0
	SN/Go-Me, degrees	33.0 ± 5.0	36.0	35.0
	SN/ANS-PNS, degrees	8.0 ± 3.0	10.0	10.0
	ArGoMe, degrees	130.0 ± 7.0	125.0	125.0
Dentobasal	Maxillary incisor inclination (U1^PF), degrees	107.5 ± 3.5	120.0 107.5 ± 3.5	118.0
	Mandibular incisor inclination (IMPA), degrees	94.0 ± 5.0	115.0	105.0
Dental	Horizontal overlap, mm	2.5 ± 2.5	5.0	3.0
	Vertical overlap, mm	2.5 ± 2.5	−1.0	2.0

Case presentation

The study was approved by the Ethical Committee at the University of Rome Tor Vergata, Rome, Italy (14119), and informed consent was acquired from the patient's parents.

An 11-year-old boy presented to the Department of Orthodontics at the University of Rome Tor Vergata with the chief complaint of protrusive maxillary anterior teeth (Fig 1). The extraoral examination showed a symmetrical face, convex profile and labial incompetence, and the intraoral examination revealed permanent dentition, a bilateral Class II molar and canine relationship, increased horizontal overlap and negative vertical overlap. The maxilla was asymmetrically constricted, with the left side straighter than the right; the mandible also showed dentoalveolar constriction with mild anterior dental crowding and protrusion of the mandibular anterior teeth. The functional analysis revealed that tongue thrusting was a determining factor in open bite.

The pretreatment cephalometric evaluation (T0) (Table 1) confirmed a skeletal Class II relationship associated with mandibular retrusion (ANB 7 degrees, WITS 2 degrees, SNA 80 degrees, SNB 73 degrees), excessive horizontal overlap (OVJ 5 mm) and negative vertical overlap (OVB −1 mm). The skeletal divergence angles were within a normal range (FMA 26 degrees, SN-GoGn 36 degrees). The mandibular and maxillary incisors were proclined with respect to their basal bones (U1/PF 120 degrees, IMPA 115 degrees). Skeletal maturity was evaluated based on the pretreatment cephalometric data according to the CVM method[14] and the stage was found to be CS3. Orthopantomography revealed developing third molars and no underlying pathologies.

Treatment plan

The main treatment objectives were as follows:

- maxillary and mandibular expansion to recover the proper symmetrical transverse dimension;
- intrusion of the posterior teeth to achieve an optimal vertical overlap with careful management of functional anomalies and correction of incisor inclination;
- correction of the Class II dentoskeletal relationship using intermaxillary Class II elastics to promote anterior repositioning of the mandible.

Additional treatment goals involved levelling and aligning, improving the facial profile and obtaining a natural lip position.

The digital treatment plan (ClinCheck, Align Technology) involved simultaneous expansion of the maxilla and distorotation of the maxillary first molars according to the line

of Ricketts[15]. The requested amount of expansion was 4 to 6 mm, and 2 degrees of extra buccal root torque were required for each phase of expansion.

Direct bonded attachments were planned from the third phase to improve patient compliance. Retentive attachments were placed on the posterior teeth to maintain optimal aligner fit.

Intrusion of the posterior teeth was required to correct the anterior open bite. The Invisalign system appears to have an occlusal rim effect because two 0.75-mm aligners were interposed between the posterior teeth throughout treatment, providing vertical control. Over the course of treatment, the patient underwent speech therapy for functional rehabilitation.

Interproximal reduction (IPR) was performed in the mandible, promoting retroclination of the mandibular incisors to recover the amount of horizontal overlap necessary for forward mandibular displacement. Moreover, during expansion, palatal inclination of the maxillary incisors was requested. As a result of retroclination of both the maxillary and mandibular incisors, relative extrusion of the anterior teeth was planned.

After expansion, to provide retention for use of interarch elastics, precision cuts were designed on the aligner surface to achieve anterior repositioning of the mandible. Elastics were hooked directly from precision cuts on the maxillary canines to bonded metal buttons on the buccal surface of the mandibular first molars. The patient was instructed to wear Class II elastics (4 oz, 3/16") on a full-time basis.

After the active treatment, the patient started a retention protocol with Vivera retainers (Align Technology) to be used every night for an indefinite period. In addition, he underwent regular checks to evaluate the stability of the therapeutic results.

Treatment results

The first phase of treatment lasted 9 months and involved the use of 34 aligners in the maxilla and 34 in the mandible. The patient was instructed to change his aligners every 7 days and showed excellent compliance, and the treatment objectives were achieved.

At the end of treatment, intraoral examination (Fig 2) revealed symmetrical and well-shaped arch forms, a bilateral Class I molar and canine relationship, a reduction in horizontal overlap and a positive vertical overlap. Moreover, extraoral analysis revealed a significant improvement in the soft tissue profile with a more anterior chin position, proper incisor exposure and a wider smile as an effect of the increase in torque values in the lateroposterior segments.

The effects of therapy were evaluated cephalometrically (Table 1) at the end of treatment (T1). A reduction of 4 degrees in the ANB angle (T0 7 degrees, T1 3 degrees) was achieved, mainly as a result of forward mandibular displacement (SNB T0 73 degrees, T1 77 degrees). Both mandibular and maxilary incisor proclination were reduced, particularly in the mandible (IMPA T0 115 degrees, T1 105 degrees; U1/PF T0 120 degrees, T1 118 degrees). Normal horizontal and vertical overlap were also obtained (OVJ T0 5 mm, T1 3 mm; OVB T0 −1 mm, T1 2 mm). The overall superimposition of the lateral cephalometric radiographs according to Björk's method (cephalograms are superimposed on SN at S) is shown in Fig 3[16].

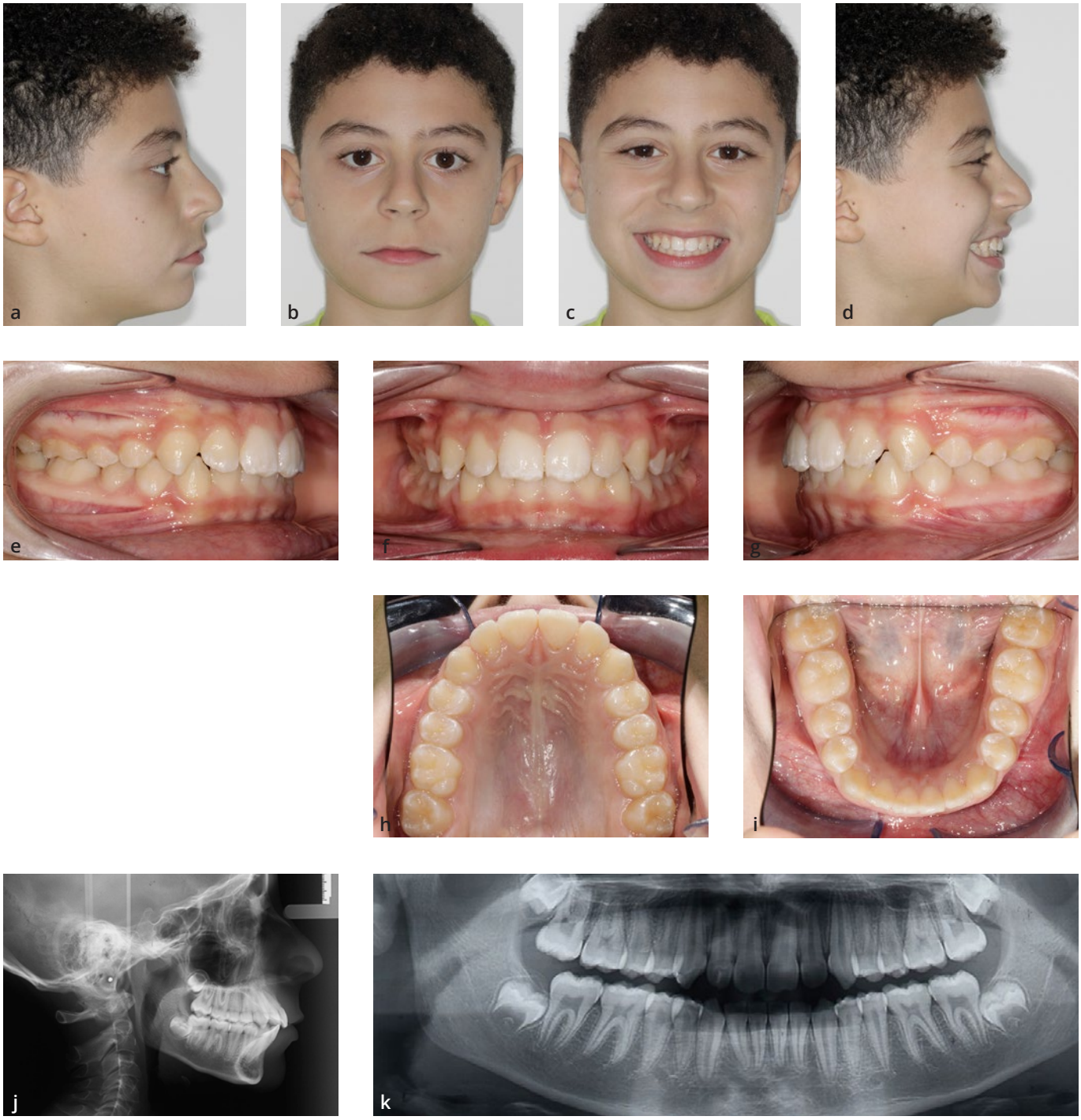
Discussion

Clear aligners have demonstrated excellent results in improving the transverse dimension and vertical overlap, correcting the sagittal relationship and achieving anterior alignment. Arch development, molar intrusion and overbite correction with anticlockwise mandibular rotation were predictably achieved, respecting the digital setup and creating a proper Class I bilateral occlusion.

A specific protocol was followed during treatment planning: transverse expansion, control of the vertical dimension, and sagittal correction using Class II elastics. The improvement of the transverse dimension made it possible to avoid occlusal interferences during anteroposterior movement. The maxilla, which initially appeared asymmetrical, became symmetrical because of the expansion achieved.

It has been shown that up to 85% of Class II patients present mesial rotation of their maxillary first and second molars[17], and for this reason, correction of rotations was performed during expansion to allow coordination between arches and to move the molars, premolars and canines into a Class I relationship at an early stage during treatment.

Prior to the development of Invisalign G8 (Align Technology), during transverse movement, overcorrection with extra buccal root torque (2 degrees for each phase of expansion) was necessary to overcome the side effects of



Figs 2a-k Posttreatment records.

dental tipping produced by the aligners pushing against the palatal tooth surfaces during expansion. Now, with G8, new optimised attachments have been introduced to support expansion and improve root control movements.

Several studies have reported a property related to the use of clear aligners: vertical control due to the occlusal rim effect[18-20].

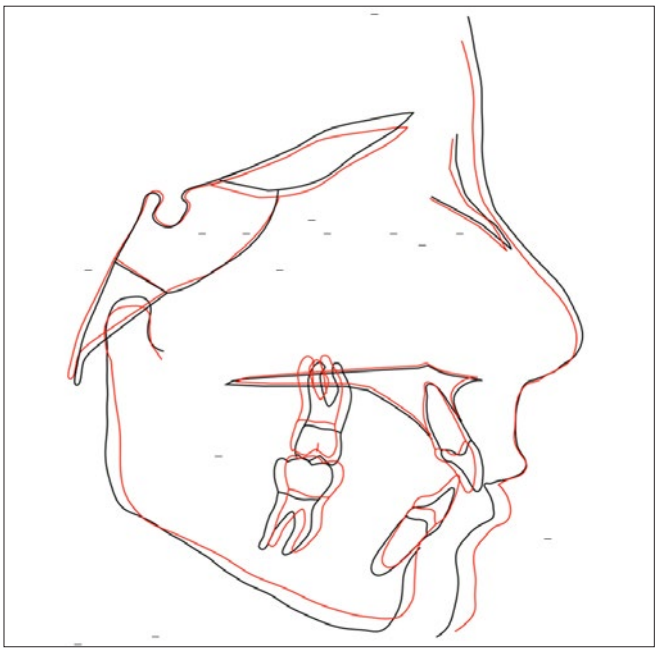


Fig 3 Superimposition of pre- and posttreatment cephalometric tracings according to Björk's method.

The use of clear aligners could make it possible to change the traditional paradigm of open bite treatment and redirect the occlusal forces: the thickness of the aligners (1.5 mm) creates a premature contact like a posterior buildup that promotes molar intrusion in the same direction as the force exerted by the aligners[21].

Open bite closure was achieved by intrusion of the posterior teeth and extrusion of the maxillary anterior teeth. Posterior intrusion was the result of digital planning and the naturally minor intrusive effect of the aligners. Extrusion of the maxillary anterior teeth was achieved through relative extrusion during retroclination.

The present case report showed that aligners allow optimal vertical control and can cause molar intrusion followed by anticlockwise mandibular rotation due to the occlusal rim effect of two layers of aligner material between the dentition for 22 hours per day over 9 months of treatment.

Interarch mechanics with Class II elastics were performed to restore the correct sagittal relationship through functional rebalancing of the oral and perioral muscles. Wearing Class II elastics exerts a constrictive force on the maxilla, so the amount of expansion indicated on the ClinCheck may not occur in clinical practice. The present authors' experience suggests that Class II elastics are required after arch expansion. Custom-formed composite resin attachments were placed to improve aligner retention and provide support during interarch mechanics with Class II elastics.

Several studies have reported that the use of Class II elastics results in adverse effects such as mandibular anchorage loss, mandibular molar extrusion, clockwise rotation of the occlusal plane and mandibular incisor proclination. An important advantage of this orthodontic technique is that aligners prevent extrusion of the teeth despite the use of Class II elastics and therefore enable suitable vertical control. The decision to use precision cuts was dictated by the proclination of the mandibular and maxillary incisors. In the maxillary aligner, a hook was designed to avoid further proclination of the incisors, whereas in the mandible, a button was placed on the buccal surface of the first mandibular molar to prevent further proclination of the incisors. The use of Class II elastics on aligners can also allow greater freedom of movement of the mandible and thus facilitate mesial mandibular repositioning during the pubertal growth spurt.

Clear aligners offer various advantages such as ease of use and improved aesthetics, comfort and hygiene. When compared to conventional fixed appliances, aligners cause less pain and have fewer negative impacts on patients' lives[22,23].

Potential disadvantages of the use of aligners in growing patients are the varying degrees of predictability of planned movements and the level of compliance. Different tooth movements have different levels of predictability, and the clinician must be qualified and experienced in order to deliver precise treatment. In addition, since clinical success depends on the patient wearing their aligners, the results will not be as expected if they are not fully compliant. Careful case selection is critical because of the increased need for patient compliance and cooperation when wearing elastics. Compliance seems likely with clear aligners, however, due to the comfort and aesthetics they offer.

Conclusion

In the present case report, the amount of molar intrusion was consistent in both the maxilla and mandible, promot-

ing anticlockwise mandibular rotation with mandibular forward projection and correction of open bite. In addition, aligners combined with maxillomandibular elastics enabled Class II malocclusion to be resolved, inducing mandibular repositioning and providing the patient with a comfortable, practical and aesthetic appliance. The Invisalign system can be considered an efficient approach for treatment of Class II growing patients with mandibular retrusion. Clear aligners proved to be highly effective in resolving open bite by causing molar intrusion due to the thickness of material covering the posterior teeth coupled with the occlusal force exerted by patients. Class II elastics can induce mesial mandibular repositioning when applied during the pubertal growth spurt.

Declaration

The authors declare there are no conflicts of interest relating to this paper.

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